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ABSTRACT

The principal thesis of this paper is that successful use of high technology for conversation, writing, and computer access aid systems requires a holistic perspective. A holistic approach is one in which all the components of the support system needed to use high technology effectively are in place. Recognizing that aid systems are tools helps people use their experience with other technological tools to identify the necessary components to apply high technology successfully. It is suggested that in the future professionals will be designated to provide such holistic application, and that aid systems will be produced by programming and configuring general market devices. The use of a standardized modular system to design high technology aid systems is advocated and it is suggested that third party funding sources will provide ongoing support. (CL)

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THE HOLISTIC APPLICATION OF HIGH TECHNOLOGY FOR CONVERSATION, WRITING, AND COMPUTER ACCESS AID SYSTEMS

BARRY L. RODGERS

ABSTRACT

In order to successfully use high technology for conversation, writing, and computer access aid systems I believe we must apply it holistically. A holistic approach is one where all the components necessary are in place. Recognizing the difference between technological toys, tools, and appliances and recognizing that aid systems are tools that will allow us to use our experience with other technological tools to identify the necessary components to apply high technology successfully. This will suggest among other things, that providing services such as ongoing training to comfortably use the aid system in real situations is as important as providing the device itself. Many of these services will be provided by a professional "Aid System Integrator."

In the future, the physical part of high tech aid systems will ride on the COATTAILS of general purpose computer devices. Many high tech aid systems will be designed using off the shelf portable computers in a standardized modular aid system I call the GAIN System. Finally, in order for high tech aid systems to be used successfully third party funding sources will provide ongoing support for holistic application and much of this will be for needed services.

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A Holistic Perspective

I suggest that by using a holistic approach to the application of high technology that we greatly increase the chance it will live up to its promise for improving the lives of disabled people. By holistic application I mean making available all the components of the support system that are necessary to use high technology effectively. With a holistic perspective we understand that the whole system is greater than the sum of the parts and that parts by themselves are relatively useless. This suggests that the potential value of high technology will only be reached when all the components necessary to totally use it are in place.

In order to successfully use high technology for conversation, writing, and computer access aid systems we must apply it holistically, we must create a complete application system. If any parts are missing or malfunctioning the usefulness of high tech aid systems is greatly diminished or destroyed. This is analogous to the successful use of microcomputer systems. A typical computer without an appropriate task, appropriate software, effective documentation, a trained operator, electric power, or a desk to set it on is useless.

In order to apply high tech aid systems holistically we need a perspective that helps identify all the components necessary. I would like to give you a perspective that does this. I hope that it will help you think about what is needed to successfully use high technology for disabled people. I believe that if we hold a clear vision of what is needed we will be able to find

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ways to provide it.

To make it easier to understand this vision of the holistic application of conversation, writing, and computer access aids I will describe it as if it will definitely be used in the future. Of course it may not, but I think this perspective of the holistic application of high tech aid systems has much to offer in helping to realize the potential benefits of high technology for disabled people.

1. By comparing technological toys, tools, and appliances we recognize that high tech writing, conversation, and computer access aid systems are tools. We recognize that like other tools the results obtained with them depend as much on the skill of the user as on the quality of the tool. This suggests in turn that in the future providing ongoing training to comfortably use the aid system in real situations is as important as providing the aid system itself.

The technological toys I am referring to are promoted as useful tools but lack real usefulness. They are actually intriguing demonstrations of the possibilities of technology and I call them technological toys because they are primarily novelties. They are typically more trouble to use than they're worth. They are often hard to set up, often turn out to be harder to use and more expensive than more traditional approaches, and they have to be pampered or they will get out of adjustment or break. An example of toys that are sold as tools are the $12 magic kitchen slicer, dicers occasionally advertised on TV. If you've ever bought one of these, as I have, you know that after the novelty wears off they end up in a closet. How often do you really need a half gallon of sliced onions?

Appliances are devices that do something without requiring skill from the user. A perfect appliance is "goof" proof and is completely automatic. The results are independent of the skill of the user. A self defrosting refrigerator is a good example of an appliance. All you do is plug it in. There is no skill to learn that affects the results. It maintains its internal environment automatically. Most people today are more familiar with automatic appliances than they are with tools.

Tools to me are devices that are used by a skilled person to do something necessary in their daily life. The chief characteristic of a tool is that the results obtained with it depend on the skill of the tool user. A good example of a tool is a kitchen stove. It helps you cook but the results you get depend on your skill as a cook. With the same stove I may be able to heat a can of chili while another person is able to create a gourmet meal. The results you get with the stove depend on how skilled a cook you are.

A good tool is a work of art. Learning to recognize a good tool is sometimes difficult unless you are a master tool user. Subtle differences that are often difficult or impossible to describe make the difference between a tool and a fine tool and a piece of junk. How do you quantify the difference between a knife that feels good in your hand and one that looks the same but does not feel as good.

Conversation, writing, and computer access aid systems are tools because the results obtained with them depend on the skill of the user. They require a commitment on the part of the user to practice and develop skill in applying them to everyday needs and situations. They are tools because they must be improved by observing their use in different real situations to do important necessary tasks. By learning to recognize high tech aid systems as tools people can avoid being frustrated by trying to use technological toys.

High tech aid systems must be more than technological toys because

people depend on them, have to live with them, are judged by the results they get with them. Good tools make any task easier. Toys can make any task difficult. Even a master carpenter will find it impossible to make a square cut if she or he has to use a toy saw. Technological toys that are tried as aid systems will be rejected because they're more trouble than they're worth. People will not be dependent on toys.

Conversation, writing, and computer access aid systems will never be appliances either. At best conversation, writing, and computer access aid systems will be tools that act as effective mediums of communication. Aid systems will never work independently of the user the way an appliance can. That would be analogous to having a telephone carry on a conversation for you. It would be like having your mother talk for you. Most people want to speak for themselves.

People often confuse good tools with appliances. The telephone is a good tool and can be confused with an appliance because it is relatively easy to use and is very reliable. However, it is not automatic. For a given purpose such as selling it still has certain advantages and certain limitations. It is up to the user to maximize the advantages and minimize the limitations. The telephone itself can't help with this. Some people can be very persuasive on a telephone. Others have difficulty sounding sincere. The results of the conversation still depend on the skill of the user just as the results of conversation using any other conversation aid will depend on the skill of the user.

The fact that conversation, writing, and computer access aid systems will never be appliances suggests that users will always have to spend time and energy to develop skill in using them successfully. Users will understand that these systems can never be automatic like other appliances, that no super computer can converse for them just as no person can converse for them. They will understand that the results they get will depend in large part on training and on their determination to develop skill.

Conversation and writing aid systems are like musical instruments. Musical instruments are superb examples of what I mean by tools because the quality of the music depends on the skill of the musician. A fine guitar is a fine tool and a virtuoso guitarist is a master tool user. Musical instruments are like conversation and writing aids because they are mediums of communication. The dedication, training, practice time, and skill required to communicate with a musical instrument demonstrates characteristics required to use a conversation, writing, or computer access aid successfully. A good conversation aid user literally "plays" their aid system the way a musician plays a musical instrument. This requires training and practice. We don't expect to get music from someone by simply putting a saxophone in their hands. Mastering an instrument requires an understanding on the part of the learner that it may take time before they can make satisfactory music and that they will need the help of a teacher.

This points out the importance of making aid systems that will be easier to learn. If all conversation aid systems were as difficult to learn as a violin is for nondisabled people then very few people could benefit from them. It points out that good aid systems will be as beautiful, reliable, and practical as a good guitar. It points out that effective and ongoing training to comfortably use the aid system in real situations will be as important as providing the system itself. It points out that developing mechanisms to accumulate wisdom about successful strategies for aid system use from the master users and mechanisms to pass that wisdom on to new users will be an important component in the evolving usefulness of aid systems.

2. Recognizing high tech aid systems as tools allows us to understand that high tech aids are perfected from actual use over time. It allows us to understand that aid system designer/developer/manufacturers will be people who get their primary satisfaction from seeing their systems used successfully in real situations. They will also be people who like to continuously perfect and improve their systems.

Tools are perfected over time. Most common hand tools have been perfected through generations of use by master crafters. This is an important difference between a "technological toy" and a "tool." Technological toys appear and disappear quickly and thus never get improved and refined to the point where they are really useful.

A true technological "tool" must go through a series of cycles of improvement. These cycles consist of field use by the master crafters who use the device day in and day out, followed by refinement by the tool maker based on the feedback of these master craters. To get a useful tool, I think takes at least 3 cycles and may take many more. A characteristic of truly useful tools is that they are always undergoing refinement. After thousands of years of use there are companies that are still refining the kitchen knife.

In the future, we will be able to recognize conversation, writing, and computer access aid systems that are truly useful tools by observing their refinement over time. Orphan systems that have stopped evolving will be recognized as bad risks. Systems that are undergoing continuous refinement from actual field experience will be highly valued and sought after. Systems that have visible and viable mechanisms for fostering their improvement in use will be the most prized of all.

Tools are made by toolmakers and toolmakers can be distinguished from puzzle solving toymakers. in the future, we will distinguish tools from technological toys by understanding the characteristics of toolmakers as compared to puzzle solvers. I believe that technological toys are often made by puzzle solvers. Puzzle solvers are people who are motivated and get much satisfaction from solving puzzles.

New technological opportunities are like puzzles for them. They play with technology to see what they can get it to do. They treat high tech components as puzzle pieces to be fit together into a device that meets some idealized and abstracted use. The internal question is often "I wonder if this device can do that?", "I wonder if this microprocessor has enough power to do a text to speech translation?" However, once the puzzle fits together, once the demonstration has been made, that puzzle becomes boring. The puzzle solver then moves on to something else.

The toolmaker is a different breed entirely from the puzzle solver because the toolmaker gets satisfaction from seeing his or her tools used by people. Piecing together a device and getting it to operate is only the first and perhaps least important task of the toolmaker. The toolmaker is interested in perfecting the device in use. This means getting people to try the device, watching them try to use it, questioning them on how to improve it, taking it back and fine tuning this or shaving a little off that or even throwing it out and starting over.

To the puzzle solver it really doesn't matter whether or not the technological device meets a real need or is really useful. The satisfaction for them comes from solving the problem as first abstracted in their mind. This abstract postulate is the challenge. Even though some puzzle makers imagine that they have created a tool, it can be very frustrating for them to have someone actually try to use their device. This is

because all the real conditions and limitations spoil the sense of satisfaction the puzzle solver gets from the perfection of their abstract solution.

On the other hand, the toolmaker's main satisfaction comes from seeing the tool used by people. The toolmaker goes to great lengths to get feedback from the master crafter, the master tool user. The real life complications and the inevitable compromises are exciting challenges to the toolmaker. The art of making a useful tool is as much a concern with how people work as with what technology can do.

Good toolmakers are recognized as artists. Like other artists they must constantly see their work in context. They must constantly make precise compromised judgments that rely on their ability to see the entire system including the person using it at once; to be able to anticipate the subtle interplay of the components that will create a synergistic whole; to create a system that works unexpectedly well.

3. Recognizing high tech aid systems as tools also allows us to use our experience with other high tech tools to identify the functions necessary for holistic application. Holistic application is providing everything necessary to be successful.

The holistic application of a high tech aid system will require the following components:

1) Locating people who can make use of the aid system.
2) Establishing their needs and capabilities and the potential benefits of an aid system.
3) Selecting and acquiring appropriate system components including special market hardware and software, and general market hardware and software.
4) making simple modifications to hardware and software if necessary to make it compatible.
5) Assembling the aid system.
6) Mounting the aid system on the users wheel chair, shoulder bag, bed, etc.
7) Fitting the aid system to the user including adjustments, modifications, and initial customization.
8) Selecting the most effective aid system training aids (manuals, video tapes, demonstration programs, etc.)
9) Initially training the user in the basics of the system and how to optimize it for themselves.
10) Training the people in the users environment who will need to help the user maintain the aid system.
11) Providing ongoing training to make sure users get all possible benefit from the aid system
12) Being on call to answer subsequent questions about the aid system as it is being used.
13) Providing ongoing preventive maintenance and replacement of worn-out parts.
14) Providing repairs.
15) Updating the system when significant improvements in available functions make it desirable.
16) Periodically evaluating the degree of integration of the aid system in the user's life and providing suggestions or further training as necessary.
17) Using information gained from users in the refinement and improvement of the aid system.
18) Providing a different more appropriate aid system when the user's needs or capabilities change.
19) Providing a different more appropriate aid system when significant advances in aid system design make more useful aid systems available.

Notice that only item #3 focuses on the hardware and software itself. The other 18 items relate to services to support the user and the system over time. This points out that when high tech devices are "Holistically applied" services such as systems integration and ongoing training will be at least as important as the devices themselves.

4. In the future, in order to provide many of the functions of holistic application there will be a professional "Aid System Integrator" working for aid system users or third party funders.

Many of the services required for holistic application of high tech conversation, writing, and computer access aid systems require a person with unique knowledge and experience. I call this person an Aid System Integrator because they will be able to integrate the components into an appropriate aid system and because they will be able to help the user integrate the aid system into their lifestyle. There are already people doing this work but in the future they will have a clear identity and role and be committed full time to this profession.

The Aid System Integrator will be the user's technological consultant, advisor, and advocate helping him or her get the most from available technology. The Aid System Integrator will work for the user in putting together the most appropriate aid system in conjunction with other therapists such as speech and language pathologists, seating specialists, and occupational therapists. They will provide the primary support for the aid system. They will provide many of the services listed earlier including helping users select, put together, setup, and learn to use aid systems. They will provide ongoing evaluation, training, adjustment, modification, and repair of the aid systems.

In the future, the Aid System Integrator will work for aid system users or third party providers on a fee for service basis. They will not represent a single designer/developer/manufacturer but will work with all designer/developer/manufacturers just as an independent insurance agent works with many different insurance companies. They will be paid for services in the same way other professionals such as dentists and accountants are. They will establish long term relationships with their clients.

The Aid System Integrator will be comfortable with high tech devices and will be trained to confidently assemble aid systems from devices made by different manufacturers. They will be a special kind of toolmaker. One who assembles tool systems from available components. They will have a technicians knowledge of electronics and be comfortable with simple computer programming tasks. They will also be trained in locating resources. A big part of their service and expertise will be in keeping up with what is available for special needs.

Aid System Integrators will also be people oriented. They will be trained to be good teachers. They will teach people to become proficient with their systems and to feel good about using them. They will be comfortable working together in a team with other clinicians such as speech and language pathologists and occupational therapists. They will be the sort of people who get satisfaction from seeing their systems used successfully in daily service by their clients.

5. In the future, the physical part of high tech conversation, writing, and computer access aids will ride on the COATTAILS of general market computerized devices.

Most of the physical part of these aid systems will be designed around general market high tech computers. I call this approach to aid system design the COATTAILS APPROACH which is an acronym for Computer

Opportunities Applied To Technological Aids In Linked Systems.

> Computer Opportunities refers to the opportunities to make powerful yet inexpensive aid systems from general purpose computers as well as from other high tech consumer devices such as phone based environmental monitors and remote controlled entertainment systems. These general market high tech devices will cost less and less with more and more capability.
>
> Applied to Technological Aids means that we will apply this technology to making electronic aid systems for writing, conversation, and device access for disabled people.
>
> In linked Systems means that the aid systems will be systems configured by linking general market devices to specially made devices. The special market devices will act as accessible inputs for the general market devices. The linked system is modular and expandable with almost unlimited possibilities.

The COATTAILS Approach will be widely used because it will be more effective to make aid systems by programming and configuring general market devices than it will be to manufacture from scratch the entire aid system. There will by many reasons for this. Among them that this approach will require less capital investment, less development time, will be more efficient for small production, will be less expensive, will require less manufacturing expertise, will be more customizable, and will significantly reduce the time it takes to bring out a refined updated aid system.

Most of the "work" of "manufacturing" the aid systems will be in researching aid techniques, programming the general market devices, and in creating the effective training materials that will be part of the aid system. Relatively little work will be in traditional "manufacturing."

In the COATTAILS Approach manufacturers will be using off the shelf devices that anyone could buy separately. This will make the costs of "manufacturing" the system obviously separate from the cost to manufacture the hardware. It will be obvious that the value added to make an aid system is in development, programming, and training materials. Developing good software and effective training materials is expensive now and there are no indications that it will get significantly cheaper.

For this reason, users will understand that the aid system they get from the designer/developer/manufacturer via their Aid System Integrator is worth significantly more than the cost of a naked computer. In fact the "cost" of holistically applying the high tech aid system may have little or no relationship to the cost of the hardware.

6. In the future, many high tech aid systems will be designed using a standard portable computer in a standardized modular system I call the GAIN System.

This is one kind of COATTAILS aid system. It will be designed around battery powered portable computers. I call it the Gain system because of the gains in versatility and cost benefit ratio and because this is an arcronym that stands for Generic Aid I/O Network.

> Generic means that any brand portable computer may be suitable.
>
> Aid in this case means a high tech computer based conversation, writing, and computer access aid system.
>
> I/O stands for Input/output and refers to how special input

or output devices will be connected to the generic computer to make an aid system. The connections themselves will be generic or nonspecialized using standard ports already present on the generic computer.

Network implies that the system extends in several possible directions from the adaptive computer to the user and from there extends in many possible ways to other people and devices.

The GAIN System will be based on a general purpose battery powered notebook computer acting as an adaptive computer. The adaptive computer runs special software that allows it to adapt to the person using it. The software for the adaptive computer will be designed to take advantage of whatever communication/control capabilities a person has.

The GAIN System uses the standard input and output RS-232 ports on the adaptive computer. Specially made input devices, such as a chin control, will connect to the adaptive computer in a standardized way. Specially made interfaces allow the output of the adaptive computer to control other computers and other devices that a person needs access to in their culture. These specially made interfaces connect to the adaptive computer in standardized ways. By linking with other electronic devices in a person's environment the adaptive computer becomes part of a network that extends indefinitely. Thus the Generic Aid I/O Network gains access and gains power.

Here are the defining "attributes" of the GAIN System:

1) Uses a general purpose battery powered computer (Epson HX-20, Radio Shack Model 100, etc.).
2) Makes use of the computer's standard input and output ports.
3) Uses special market and general market input devices with stationary devices.
4) Uses a special market wireless link to connect the system to stationary devices.
5) Uses a keyboard emulating interface to access a standard computer.
6) Uses a Special market remote control emulator that can directly control general marker stereos, TVs, lights, telephone answering machines, emergency call systems, microprocessors, coffee pots, etc.

Here are the main benefits or "features" of the GAIN System:

1) Inexpensive hardware.
2) Modular can be tailored to particular needs.
3) Requires no hardware modifications to the off the shelf computer.
4) Portable but networks with stationary systems.
5) Can control standard computers running standard software.
6) Can be upgraded via software alone and the software can be modular to make changes and revisions easier.
7) Allows a manufacturer to develop an aid system without having to "manufacture" hardware.

Taken together GAIN implies the synergetic effect where the resulting system will be greater than the sum of its parts, a new gain. GAIN systems will be multifunction modular aid systems that are less expensive, more versatile, upgradeable, repairable, and improvable, and therefore, more likely to be truly useful to a disabled person.

GAIN systems will often be "configured" or put together rather than "manufactured." Since the physical part of the systems will be in large part inexpensive off the shelf devices and since most of the cost of the GAIN Systems will be in integrating these components with appropriate software and user training, the GAIN

Systems will more clearly service intensive. It is likely that pricing, delivery, and support will use the "service" model rather than the "product" model. For example, an environmental control system may be packaged and delivered the way some home security systems are today. You pay the professional security system designer for the time it takes to evaluate your needs and install and support your system. The cost of the components is listed in the bill under "parts." To look at this another way, you pay your dentist for her or his time and the cost of materials is usually negligible in comparison. You don't go to a dentist to buy a filling and get free installation.

7. In the future, when funding sources are needed they will provide ongoing support for everything needed to "holistically apply" high tech aid systems including needed services.

Funding by third party sources for high tech aid systems will include all the costs for making the systems truly useful. Society will have an understanding and acceptance of the ongoing need to support both the user and the aid system and this understanding will be reflected in policies by funding agencies.

To see how this would work in the future for high tech aid systems we can use the example of a mobility system consisting of a van, a wheelchair lift, and a wheelchair. The purpose of the system is to provide ongoing reliable mobility for a person so she or he can contribute in a regular job. What is the cost per year to support part of this system? Let's say the van with wheelchair lift and modified controls cost $11,000. Is this a one time cost to provide mobility for a person so that they can hold a job and participate in society? No, we know that it costs much more "over time."

In the future, part of the yearly cost would be computed as follows. In Wisconsin this van would last about 8 years before it rusted out. A 20 year old person needing mobility for 50 years or so would need at least 6 vans or a van every 8 years. This would be about $11,000/8 yrs = $1375/per year. The cost of the van does not include maintenance and repair so we must add an additional amount for that. At 10 cents a mile for maintenance on the van and 10,000 miles a year we must add $1000 a year. Thus this part of the cost to give a person mobility via a van is about $2375 per year.

This is still only part of the cost to apply the van technology holistically. In the future the cost to learn to operate the special controls of the van will be covered. Since each new van might have different controls the training will be paid for every time it is needed. In addition, the regular maintenance and repair cost on the wheelchair lift have not been added in yet. They will also be covered. The wheelchair is intrinsic to this system so ongoing maintenance and repair for it must be added in. Like everything else wheelchairs wear out so the cost to replace the wheelchair periodically must be added.

What about the cost to consult experts about the best kind of lift and the most appropriate control system to select for each new van. The technology will continue to change. Driving and the vans themselves will likely change with time. Only an unbiased expert will be able to make a good decision about what kind of system to get. In the future the services of this expert will also be paid by third part funding sources.

Thus, there are many ongoing costs that must be covered to successfully provide mobility with a van and wheelchair. Vans are relatively easy to learn to drive and easy to maintain compared to many computer based conversation, writing, and computer access aid systems. These systems may require even more ongoing support. Therefore,

in the future if third party funding sources are needed they will support all the costs necessary to apply the high technology for aid systems holistically. This will include:

1) The cost of evaluation services
2) The cost of system integration and assembly services
3) The cost of the hardware and software components of the system
4) The cost of initial training services to learn to use the aid system
5) The cost of ongoing training services related to developing skill in using all the power and versatility of the aid system (this is different from and in addition to speech and language therapy, occupational therapy, etc.)
6) The cost of periodic maintenance services (cleaning keyboards and switches, adjusting and tightening mountings, etc.)
7) The cost of normal periodic parts replacement (like nicad batteries every 3 years)
8) The cost of repair services from equipment failure or accidental damage (LCD display going bad, spilling juice on the keyboard, etc.)
9) The cost of periodic system upgrade for both the materials (software and hardware) and the installation and training services (this will be necessary because manufacturers will refine systems over time fixing bugs and adding features)
10) The cost of replacing the system after its useful lifetime is finished (this will be necessary when the users physical or mental capabilities and needs change even if their aid system still operates)
11) The cost of comprehensive insurance to fix or replace the system if it is damaged or stolen.

It is worth noting again that most of these costs will be services.

To Sum Up

In order to apply high technology effectively we need a holistic vision where all the parts necessary to make a whole system are in place. By comparing technological toys, tools, and appliances we recognize that high tech writing, conversation, and computer access aid systems are tools and that like all tools the results obtained depend as much on the skill of the user as on the quality of the tool. This suggests in turn that in the future providing ongoing training to comfortably use the aid system in real situations is as important as providing that aid system itself.

Recognizing high tech aid systems as tools allows us to understand that high tech aids are perfected from actual use over time and that aid system designer/developer/manufacturers will be people who get their primary satisfaction from seeing their systems used successfully in real situations and they will be people who like to continuously perfect and improve their systems. Recognizing high tech aid systems as tools also allows us to use our experience with other high tech tools to identify the functions necessary for holistic application, where holistic application is providing everything necessary to be successful. In order to provide many of the functions of holistic application there will be professional "Aid System Integrators" working for aid system users or third party funders.

The physical part of high tech aid systems will ride on the COATTAILS of general purpose computer devices because this approach is more effective in developing aid systems into tools. Many high tech aid systems will be designed using a standard portable computer in a standardized modular system I call the GAIN System. Finally, in order for high tech aid systems

to be used successfully third party funding sources will provide ongoing support for holistic application and much of this will go for needed services.

By understanding aid systems as tools we will be able to use our experience with other tools to help create ways to provide and use aid systems appropriately. By using this model we can develop appropriate approaches for designing, manufacturing, selecting, improving, learning, using, paying for, maintaining, insuring, repairing, and replacing high tech aid systems.